IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application

Inventor(s):	ANDREW ROMAN CHRAPLYVY et al.		
Case:	Chraplyvy 28-16-5-3-1-7 (ALU/124225)		
Serial No.:	09/990,964	**Group Art Unit**:	2613
Filed:	11/21/2001	**Confirmation #**:	3319
Examiner:	Li, Shi K.		
Title:	LONG HAUL TRANSMISSION IN A DISPERSION MANAGED OPTICAL COMMUNICATION SYSTEM		

MAIL STOP APPEAL BRIEF-PATENTS
COMMISSIONER FOR PATENTS
P.O. BOX 1450
ALEXANDRIA, VA 22313-1450

SIR:

APPEAL BRIEF

Appellants submit this Appeal Brief to the Board of Patent Appeals and Interferences on appeal from the decision of the Examiner of Group Art Unit 2613 mailed December 17, 2008 finally rejecting claims 1, 10-13, 15, 16 and 21-28.

In the event that an extension of time is required for this appeal brief to be considered timely, and a petition therefor does not otherwise accompany this appeal brief, any necessary extension of time is hereby petitioned for.

Appellants believe the only fee due is the **$540** Appeal Brief fee which is being charged to counsel's credit card. In the event Appellants are incorrect, the Commissioner is authorized to charge any other fees to Deposit Account No. 50-4802/**ALU/124225**.

TABLE OF CONTENTS

REAL PARTY IN INTEREST

The real party in interest is ALCATEL-LUCENT. The assignee of record is LUCENT TECHNOLOGIES INC, which merged with ALCATEL to form ALCATEL-LUCENT.

RELATED APPEALS AND INTERFERENCES

Appellants assert that no appeals or interferences are known to Appellants, Appellants' legal representative, or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

STATUS OF CLAIMS

Claims 1, 10-13, 15, 16 and 21-28 are pending in the application. Claims 1–18 were originally presented in the application. Claims 19-28 were added by amendment. Claims 2-9, 14, 17-20 have been canceled. Claims 1, 10-13, 15, 16 and 21-28 have been amended. The final rejection of claims 1, 10-13, 15, 16 and 21-28 is appealed.

STATUS OF AMENDMENTS

All claim amendments have been entered.

SUMMARY OF CLAIMED SUBJECT MATTER

Embodiments of the present invention relate to a coding scheme in a wavelength division multiplexed (WDM) high bit rate, long haul dispersion-managed optical transmission system using return-to-zero (RZ) pulses with data encoding by a phase shift keying (PSK) format, such as differential phase shift keying (DPSK) or quadrature phase shift keying (QPSK).

At the time of the invention, Appellants' efforts were generally directed to developing an improved multi-channel high bit rate (e.g., 40 Gbit/s) long-haul/ultra long-haul optical transmission system. Prior to Appellants' innovation, efforts were hampered by intra-channel non-linear penalties, such as intra-channel cross phase modulation (XPM) among adjacent overlapping bits that mostly leads to timing jitter, as well as by intra-channel four wave mixing (FWM), that mostly leads to amplitude fluctuations. Use of high bit rates in conjunction with long haul and ultra-long haul (ULH) transmission, particularly in the environment in which multiple channels are combined in a WDM or dense WDM system, was also made difficult, due to both worsened nonlinear impairments and increased amplifier spontaneous emission (ASE) noise, which leads to degradation of pulses as they propagate through an optical fiber path from a transmitter to a receiver, and various undesirable inter-channel effects.

Appellants overcame these deficiencies in then-known long-haul high-bit rate WDM systems through the novel use of return-to-zero (RZ) (as opposed to non-return-to-zero (NRZ)) and phase shift keying (PSK) (in contrast to intensity modulation). Advantageously, by virtue of the use of RZ-PSK the XPM penalty is mostly eliminated by removing the intensity-pattern dependence. Compared with on-off keying (OOK) (an intensity modulation format), differential phase shift keying (DPSK) for example is more tolerant to ASE noise because of its higher receiver sensitivity, especially when a balanced receiver is used, and allows for transmission with lower optical power. This also reduces FWM impairments.

In one embodiment, a digital electrical signal representing data is used to modulate the phase of a stream of high bit rate (e.g., 40Gbit/s) RZ optical pulses. In one embodiment the data is differentially encoded. A plurality of data streams are combined

in a wavelength division multiplexer and transmitted to a remote receiver via dispersion-managed fiber spans. In terms of light intensity, there is always one RZ-pulse in every bit slot. Dispersion management can be provided using several techniques, such as by using dispersion managed solitons, quasi-linear transmissions or conventional RZ transmissions. For example, the transmission medium and laser power may be managed so that the pulse transmission comprises solitons.

For the convenience of the Board of Patent Appeals and Interferences, Appellants' independent claims 1 and 16 are presented below with citations to various figures and appropriate citations to at least one portion of the specification for elements of the appealed claims.

Claim 1 positively recites (with reference numerals, where applicable, and cites to at least one portion of the specification added):

1. Apparatus adapted for use in long haul transmission in an optical communication system, comprising:

at least one modulator [105], for modulating an optical phase of pulses within a sequence of return-to-zero (RZ) pulses having a duty cycle of less than or equal to approximately 33% [Figs. 2a, Figs. 4d] to form an optical phase modulated signal encoded by one of phase shift keying (PSK) [Fig. 2d], differential phase shift keying (DPSK) [Fig. 4e] or quadrature phase shift keying (QPSK) in accordance with an input digital data stream [111, Figs. 2b-2c, Figs. 4a-4c]; [Specification p. 4 line 27-p. 5 line 15, p. 6 lines 4-15, p. 8 lines 18-20 and 28-29]

a wavelength division multiplexer [120] adapted to combine an output signal of said at least one modulator [105] with other optical phase modulated signals having optical carriers with different wavelengths; [Specification p. 5 lines 16-20, p. 6 lines 21-23]

a dispersion managed optical transmission medium [130] for transmitting an output wavelength division multiplexed signal of said

wavelength division multiplexer; [Specification p. 5 lines 18-21, p. 7 lines 1-11, p. 8 lines 4-23] and

a means for transmitting [100] the wavelength division multiplexed signal in the dispersion managed optical transmission medium [130]. [Specification p. 4 line 27]

Claim 16 positively recites (with reference numerals, where applicable, and cites to at least one portion of the specification added):

16. A method of transmission for long haul optical communications, comprising the steps of:

modulating an optical carrier signal in a sequence of return-to-zero (RZ) pulses having a duty cycle of less than or equal to approximately 33% [Fig. 2a, Fig. 4d]; [Specification p. 5 lines 1-15, p. 6 lines 4-15, p. 8 lines 18-20 and 28-29]

modulating an optical phase of said pulses in accordance with an input digital data stream [Fig. 2b-2c, Fig. 4a-4c] to form an optical phase modulated signal via one of phase shift keying (PSK) [Fig. 2d], differential phase shift keying (DPSK) [Fig. 4e] or quadrature phase shift keying (QPSK);

combining said optical phase modulated signal with other optical phase modulated signals having optical carriers with different wavelengths to form a wavelength division multiplexed signal [120]; [Specification p. 5 lines 16-20, p. 6 lines 21-23] and

transmitting said wavelength division multiplexed signal in a dispersion managed optical transmission medium [130]. [Specification p. 4 line 27, p. 6 lines 21-23]

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 10-13, 15-16, 21, 24-25 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Atia, et al. ("Demonstration of Return-to-Zero Signaling in Both OOK and DPSK Formats to Improve Receiver Sensitivity in an Optically Preamplified Receiver", IEEE Lasers and Electro-Optics Society, 12th Annual Meeting, 8-11 Nov. 1999), hereinafter "Atia" in view of Clausen, et al. (U.S. Patent No. 6,832,050 B1, hereinafter "Clausen") and Fukuchi (U.S. Patent 5,745,613, hereinafter "Fukuchi").

Claims 22-23 and 26-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Atia, Clausen and Fukuchi as applied to claims 1, 10-13, 15-16, 21, 24-25 and 28 and further in view of Doran et al. (U.S. Patent No. 7,352,970 B2, hereinafter "Doran").

ARGUMENTS

Rejection Under 35 U.S.C. 103(a)

Applicable Law

The Examiner bears the initial burden of establishing a prima facie case of obviousness. See MPEP § 2141. Establishing a prima facie case of obviousness begins with first resolving the factual inquiries of *Graham v. John Deere Co.*, 383 U.S. 1 (1966). The factual inquiries are as follows:

> (A) determining the scope and content of the prior art;
> (B) ascertaining the differences between the claimed invention and the prior art;
> (C) resolving the level of ordinary skill in the art; and
> (D) considering any objective indicia of nonobviousness.

Once the *Graham* factual inquiries are resolved, the Examiner must determine whether the claimed invention would have been obvious to one of ordinary skill in the art. The key to supporting a rejection under 35 U.S.C. §103 is the clear articulation of the reasons why the claimed invention would have been obvious. The analysis supporting such a rejection must be explicit. "[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *In re Kahn*, 441 F. 3d 977, 988 (Fed.Cir. 2006), *cited with approval by KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 126 S. Ct. 2965 (2006); *see also* MPEP §2141.

"If the examiner determines there is factual support for rejecting the claimed invention under 35 U.S.C. 103, the examiner must then consider any evidence supporting the patentability of the claimed invention, such as any evidence in the specification or any other evidence submitted by the applicant. The ultimate determination of patentability is based on the entire record, by a preponderance of evidence, with due consideration to the persuasiveness of any arguments and <u>any secondary evidence</u>." See

MPEP 2142 (citing *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992) (emphasis added)).

The References

Atia discloses the use of return-to-zero signaling (RZ) in both on-off keying (OOK) and differential phase shift keying (DPSK) modulation formats for improved receiver sensitivity as compared to non-return-to-zero (NRZ) signaling in an digital optical communication link. (See Atia, p. 226, 2nd – 3rd paragraphs). Notably Atia discloses only a single wavelength single channel configuration in an optical communication link.

Clausen discloses that the use "tedon" transmission systems using short duty cycle return-to-zero (RZ) modulated pulses is limited by system penalties in the form of timing and amplitude jitter. (See Clausen, col. 1 lines 38-43 and 61-67, col. 2 lines 1-3). To overcome these penalties, Clausen proposes adding an optimal amount of pre-chirp (pre-dispersion compensation) to the input of a transmission fiber link and adding the optimal amount of pre-chirp (post-dispersion compensation) to the output of the transmission fiber link. (See Clausen, col. 2 lines 12-24). Notably, Clausen's invention arises in the context of an intensity modulation data encoding format and does not discuss any type of phase modulation for data encoding.

Fukuchi discloses a wavelength division-multiplexing optical communication system including a plurality of modulators for modulating the intensity of a plurality of light rays, each having a different wavelength from one another, with a data signal from a data source, and a wavelength division-multiplexer for combining the light from the modulators. (See Fukuchi, Abstract).

Doran teaches a dispersion management system for soliton transmission systems in which a length of optical fiber is formed from components of opposite sign dispersion value that are concatenated together. (See Doran, Abstract). Notably, Doran is only a single wavelength channel system and is therefore not concerned with inter-channel effects. (See Doran col. 2 lines 41-43 and col. 3 lines 2-7).

Claims 1, 10-13, 15-16, 21, 24-25 and 28

Claims 1, 10-13, 15-16, 21, 24-25 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Atia in view of Clausen and Fukuchi. The rejection is traversed.

The teachings of Atia, Clausen and Fukuchi are discussed above. The alleged combination of Atia, Clausen and Fukuchi fails to render obvious Appellants' independent claims 1 and 16 because the references, alone or in any permissible combination fail to teach or to suggest all elements as arranged in Appellants' claims. In particular, the alleged combination of Atia, Clausen and Fukuchi fails to teach or to suggest an apparatus adapted for use in long haul transmission in an optical communication system, comprising at least one modulator, for modulating an optical phase of pulses within a sequence of return-to-zero (RZ) pulses to form an optical phase modulated signal encoded by one of phase shift keying (PSK), differential phase shift keying (DPSK) or quadrature phase shift keying (QPSK) in accordance with an input digital data stream and a wavelength division multiplexer adapted to combine an output signal of said at least one modulator with other optical phase modulated signals having optical carriers with different wavelengths, as recited in independent claim 1, or a method of transmission for long haul optical communications, comprising modulating an optical carrier signal in a sequence of return-to-zero (RZ) pulses, modulating an optical phase of said pulses in accordance with an input digital data stream to form an optical phase modulated signal via one of phase shift keying (PSK), differential phase shift keying (DPSK) or quadrature phase shift keying (QPSK), and combining said optical phase modulated signal with other optical phase modulated signals having optical carriers with different wavelengths to form a wavelength division multiplexed signal, as recited in independent claim 16. Specifically, Appellants' claims 1 and 16 recite:

> 1. Apparatus adapted for use in long haul transmission in an optical communication system, comprising:
>
> at least one modulator, for modulating an optical phase of pulses within a sequence of return-to-zero (RZ) pulses having a duty cycle of less than or equal to approximately 33% to form an optical phase modulated signal encoded by one of phase shift keying (PSK), differential phase shift keying (DPSK) or quadrature phase shift keying (QPSK) in accordance with an input digital data stream;

a wavelength division multiplexer adapted to combine an output signal of said at least one modulator with other optical phase modulated signals having optical carriers with different wavelengths;

a dispersion managed optical transmission medium for transmitting an output wavelength division multiplexed signal of said wavelength division multiplexer; and

a means for transmitting the wavelength division multiplexed signal in the dispersion managed optical transmission medium. (Emphasis added).

16. A method of transmission for long haul optical communications, comprising the steps of:

modulating an optical carrier signal in a sequence of return-to-zero (RZ) pulses having a duty cycle of less than or equal to approximately 33%;

modulating an optical phase of said pulses in accordance with an input digital data stream to form an optical phase modulated signal via one of phase shift keying (PSK), differential phase shift keying (DPSK) or quadrature phase shift keying (QPSK);

combining said optical phase modulated signal with other optical phase modulated signals having optical carriers with different wavelengths to form a wavelength division multiplexed signal; and

transmitting said wavelength division multiplexed signal in a dispersion managed optical transmission medium. (Emphasis added).

The Examiners' Obviousness Analysis

The final Office Action fails to cite a single prior art reference that teaches a long-haul or ultra long-haul wavelength division multiplexed (WDM) system using a phase shift keying (PSK) modulation format with return-to-zero (RZ) pulses, as may be found in Appellants' claims 1 and 16. However, the Examiner asserts that that the combined teachings of Atia, Clausen and Fukuchi render claims 1 and 16 obvious (see final Office Action p. 3). Specifically, the Examiner asserts that: (1) Atia teaches an apparatus including a phase modulator for modulating the optical phase of pulses within a sequence of return-to-zero pulses. (see final Office Action p. 2); (2) Clausen teaches a system with dispersion compensating devices and teaches the advantage of using a short duty-cycle (see Office Action p. 2-3); and (3) Fukuchi teaches a wavelength division multiplexing (see final Office Action p. 3).

As a rationale to combine Atia and Clausen the Examiner claims that the method of Clausen: "reduces timing and amplitude jitter in transmission of RZ modulated pulses. Thus, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use pre- and post dispersion compensation, as taught by Clausen et al., in the transmission system of Atia because the method of Clausen et al. reduces timing and amplitude jitter in transmission of RZ modulated pulses." (See final Office Action p. 3). As a rationale to combine Fukuchi and Atia, the Examiner asserts that "a wavelength division multiplexer" is a structure "well known in the art," and that: "It would have been obvious to a skilled artisan at the time of the invention to multiplex several modulated signals together as indicated by Fukuchi in order to efficiently utilize the bandwidth in the transmission in the modified system of Atia et al. and Clausen et al." (See final Office Action p. 3). Appellants respectfully disagree that the combination of references as alleged by the Examiner renders Appellants' independent claims 1 and 16 obvious. As set forth below, Appellants respectfully submit that the evidence of non-obviousness vastly outweighs any evidence suggesting to the contrary.

1. The Examiner fails to consider the claimed embodiments <u>*as a whole*</u> *on the entire record, including various secondary considerations indicating non-obviousness*

Appellants respectfully submit that the Examiner's analysis, using Atia as the starting point and suggesting modifications in accordance with Clausen and Fukuchi is only reasonable when based upon hindsight. MPEP 2142.02 states that "[i]n determining the differences between the prior art and the claims, the question under 35 U.S.C. 103 is not whether the differences themselves would have been obvious, but whether the claimed invention <u>as a whole</u> would have been obvious." (citing *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 218 USPQ 871 (Fed. Cir. 1983)).

The Examiner fails to consider the embodiments of Appellants' claims 1 and 16 <u>as a whole</u> and instead narrowly focuses on the differences between Atia, the primary reference, and Appellants' claims. For example, at page 2 of the final Office Action it is noted by the Examiner that "the differences between Atia et al. and the claimed invention are (a) Atia does not teach the duty cycle of the RZ pulses, (b) Atia et al. does not teach a wavelength division multiplexer, (c) Atia et al. does not teach a dispersion managed

optical transmission medium." (See Office Action p. 2). With regard to the feature of a wavelength division multiplexer the Examiner asserts that "this structure is well known in the art" and "Fukuchi teaches a WDM to combine the output signal of the modulator with other modulated signals..." (See Office Action p. 3). However, the proper inquiry is not whether a wavelength division multiplexer is obvious or well known, but whether the claimed invention as a whole would have been obvious. Limiting the inquiry to such structural differences with the prior art fails to consider Appellants' claims in the proper regard, i.e., as a whole.

For instance, Appellants' goal was not simply to expand the use of return-to-zero phase shift keying (RZ-PSK) or RZ-DPSK from a single channel implementation to a WDM system. Rather, Appellants' sought to develop an improved multi-channel high bit rate (e.g., 40 Gbit/s) long-haul/ultra long-haul optical transmission system and were not confined to considering only RZ-PSK data encoding schemes. (See, Specification p. 1-2, Background of the Invention). Prior to Appellants' innovation, efforts were hampered by intra-channel non-linear penalties, such as intra-channel cross phase modulation (XPM) among adjacent overlapping bits that mostly leads to timing jitter, as well as by intra-channel four wave mixing (FWM), that mostly leads to amplitude fluctuations. Use of high bit rates in conjunction with long haul and ultra-long haul (ULH) transmission, particularly in the environment in which multiple channels are combined in a WDM or dense WDM (DWDM) system, was additionally difficult, due to both worsened nonlinear impairments and increased amplifier spontaneous emission (ASE) noise, which leads to degradation of pulses as they propagate through an optical fiber path from a transmitter to a receiver. (See, e.g., Specification p. 1, 3rd paragraph).

Appellants overcome these deficiencies in prior long-haul high-bit rate WDM systems through the novel use of RZ (as opposed to non-return-to-zero (NRZ)) and PSK (in contrast to intensity modulation, such as on-off keying (OOK)). Advantageously, by virtue of the use of RZ-PSK formats, the XPM penalty is mostly eliminated by removing the intensity-pattern dependence. Compared with OOK, differential phase shift keying (DPSK) for example is more tolerant to ASE noise because of its higher receiver sensitivity, especially when a balanced receiver is used, and allows for transmission with lower optical power. This also reduces the FWM penalty, for example, a 3dB reduction in

power leads to 6dB reduction in the FWM effects. (See Specification p. 2-3, Summary of the Invention 5th paragraph).

The Examiner's analysis overlooks Appellants' innovation by merely combining allegedly known components in hindsight without due regard to the abovementioned challenges which Appellants faced and overcame. Appellants respectfully submit that claims 1 and 16 are non-obvious when considering the numerous advantages which the cited references completely fail to disclose.

2. No predictability or reasonable expectation of success

To support a prima facie obviousness rejection under 35 U.S.C. §103, "the prior art can be modified or combined as long as there is a reasonable expectation of success." MPEP 2143.02(I). The Examiner asserts that "it would have been obvious to a skilled artisan at the time of the invention to multiplex several modulated signals together as indicated by Fukuchi in order to efficiently utilize the bandwidth in the transmission in the modified system of Atia et al. and Clausen et al." (See final Office Action p. 3). However, this assertion casually ignores the fact that Appellants' could not simply choose to implement RZ-PSK or RZ-DPSK and immediately assume that such a multi-channel optical transmission system would be superior to other transmission formats, such as on-off keying (OOK) in a long-haul or ultra long-haul operation.

Indeed, Appellants teach in the Specification there is no predictability of success when transitioning from an optical single channel application to an optical WDM system. For example:

> While various techniques have been attempted to reduce or eliminate the effects of noise and fiber nonlinearity, these techniques have had varying degrees of success. Some techniques have proven useful in single wavelength channel systems, but do not work well in the context of WDM systems, in which many different wavelengths are combined in a single optical transmission medium.
>
> Use of high bit rates in conjunction with long haul and ultra-long haul (ULH) transmission, particularly in the environment in which multiple channels are combined in a WDM or DWDM system, has been additionally difficult, due to both the worsened nonlinear impairments and the increased amplifier spontaneous emission (ASE) noise, which leads to degradation of pulses as they propagate through an optical fiber path from

> a transmitter to a receiver and various undesirable inter-channel effects, such as inter-channel XPM and FWM.

(See, Specification p. 1-2, Background of the Invention, emphasis added). Thus, success in a single channel application is no predictor of whether a similar WDM system will also be successful. The converse is also true. For example, inter-channel cross-phase modulation (XPM) is the leading non-linear impairment in a dense wavelength division multiplexed (WDM) system while it does not exist in a single channel system. Notably, phase shift keying underperforms amplitude shift keying in a single channel system while having advantages in a WDM system due to its relative immunity to XPM. (See Provision Application Serial No. 60/299,858, filed on June 21, 2001, p. 3-4).

The Examiner using Atia as a starting point simply ignores the fact that it was unapparent to use RZ-DPSK in the first place for a long-haul high bit-rate WDM system. In fact, as discussed in greater detail below, this solution was contrary to the known teachings at the time of the invention.

Thus, for at least the foregoing reasons, Appellants respectfully submit that the alleged combination of Atia, Clausen and Fukuchi fails to render claims 1 and 16 obvious.

3. No Teaching, Suggestion or Motivation in Prior Art to Combine

In the final Office Action, the Examiner fails to establish any express motivation to combine as taught by the references themselves. Specifically, there is no suggestion or motivation found in the prior art (Atia, Clausen, or Fukuchi) that would suggest to one of ordinary skill to combine the references in such a way so as to create the apparatus as embodied in claim 1 or practice the method embodied in claim 16.

Atia teaches that the use of both on-off keying (OOK) (an intensity modulation format) and differential phase shift keying (DPSK) with return-to-zero (RZ) pulses are both advantageous in improving the sensitivity of a receiver. (See Atia p. 226, last paragraph). Clausen teaches a single channel system using intensity modulated signals (e.g., OOK) (see Clausen col. 1 lines 51-54) which is completely contrary to Appellants' teachings and the invention as embodied in claims 1 and 16 where a sequence of return-

to-zero (RZ) pulses are phase modulated. Thus, if anything, Clausen would suggest to one of skill in the art only to modify the OOK embodiment of Atia.

In addition, Fukuchi discloses WDM with non-return-to-zero (NRZ) intensity modulated signals. (See Fukuchi, Abstract and col. 1 lines 21-23). Again, this is completely contrary to Appellants' claims 1 and 16 and the teachings of the Specification. Thus Appellants submit that Fukuchi teaches the opposite of the invention as embodied in claims 1 and 16 and would not suggest to one of ordinary skill to combine the WDM system of Fukuchi with Atia and Clausen to arrive at Appellants' independent claims 1 and 16. *See generally* MPEP 2143 and MPEP 2143.02.

Thus, for at least these reasons the combination of Atia, Clausen and Fukuchi is not proper and fails to render obvious Appellants' claims 1 and 16.

4. *Examiner fails to consider the cited references "as a whole"*

In addition to the requirement that an applicants' claims be considered as a whole, a prior art reference must be considered in its entirety, including portions that would lead away from the claimed invention. (See MPEP 2141.02 (VI)).

As stated above, Atia and Clausen are single wavelength channel applications and do not discuss or suggest WDM. Atia teaches that the use of both on-off keying (OOK) (an intensity modulation format) and differential phase shift keying (DPSK) with return-to-zero (RZ) pulses are both advantageous in improving the sensitivity of a receiver. (See Atia p. 226, last paragraph). Clausen teaches intensity modulated signals (e.g., OOK) (see Clausen col. 1 lines 51-54) which is completely contrary to Appellants' teachings and the invention as embodied in claims 1 and 16 where a sequence of return-to-zero (RZ) pulses are phase modulated. Moreover, Fukuchi teaches non-return to zero (NRZ) intensity modulated signals (see Fukuchi, Abstract and col. 1 lines 21-23), which also is completely contrary to Appellants' teachings and the embodiments of claims 1 and 16.

On the other hand, Appellants teach that by virtue of the use of DPSK (or other PSK formats), the XPM penalty is mostly eliminated by removing the intensity-pattern dependence. Compared with OOK, DPSK is more tolerant to ASE noise because of its higher receiver sensitivity, especially when a balanced receiver is used, and allows for

transmission with lower optical power. This also reduces the FWM penalty…" (See, e.g., Specification p. 2-3). Thus, Appellants determined that RZ-DPSK had clear advantages over RZ-OOK in a long-haul multi-channel optical transmission system. Atia, as well as the other two references, completely fail to disclose the same and in fact teach the opposite.

Appellants respectfully submit that one of ordinary skill viewing all of the cited references in the proper context, if anything, would be lead to use RZ-OOK because Atia shows no preference for DPSK over OOK and both Clausen and Fukuchi are solely intensity modulated systems. Thus, Appellants respectfully submit that the use of RZ-PSK in a long-haul WDM system as recited claims 1 and 16 is not obvious over Atia in view of Clausen and Fukuchi.

5. The state of the art at the time of the invention discouraged the creation of the embodiments of Appellants independent claims 1 and 16 (RZ-PSK) and pointed towards OOK modulation

As further evidence of non-obviousness, Appellants note that the invention as embodied in claims 1 and 16 is contrary to the known teachings at the time of the invention. For example, as explained in Appellants' Specification:

> The advantageous use of PSK or DPSK encoding in the present invention is contrary to conventional approaches currently available to persons skilled in the art. For example, an early study [see J. P. Gordon and L. F. Mollenauer, Optics Letters, Vol. 15, p. 1351, (1990)] about phase noise caused by ASE and SPM in a single channel PSK system placed severe restrictions on PSK in a LH and ULH optical transmission system, and discouraged application of this coding method as a viable alternative. Further theoretical study and numerical simulation for conventional solitons showed excessive phase noise at long transmission distances and the need for "in-line" filters to control phase noise [see M. Hanna, et al., Optics Letters, Vol. 24, p732, (1999)]. In a recent experimental investigation [see M. Hanna et al., Electronics Letter, Vol. 37, p644, (2001)], <u>conventional DPSK solitons achieved an error-free transmission distance of ~ 1000 km, significantly less than OOK soliton systems</u>. However, in view of the present need for long reach and high bit rate WDM systems, we have recognized, for the first time, the value and feasibility of RZ-DPSK for long reach high bit rate WDM systems. Although DPSK has been proposed before for WDM systems [see M.

> Rohde, et al., Electronics Letters, Vol. 36, 1483-1484 (2000)], the desire to have constant intensity in every WDM channel in order to reduce nonlinear penalties has inevitably lead to NRZ-DPSK, rather than RZ-DPSK. It was not until recently did we realize that constant intensity is not necessary and that RZ-DPSK has significant advantages over NRZ-DPSK in LH and ULH transmission, such as reduced nonlinear penalties, higher tolerance to first-order PMD, and smaller inter-symbol interference.

(See Specification p. 9 (emphasis added); cited articles were disclosed in an IDS and are available in PAIR). In view of such teachings, Appellants submit that one of ordinary skill would have been discouraged from creating the embodiments of Appellants' independent claims 1 and 16. Rather, such a person would have preferred OOK for transmission distances greater than 1000km (i.e., long-haul).

Moreover, the teachings of Atia, Clausen and Fukuchi contain nothing that would alter this conclusion when viewed by one of ordinary skill in the art at the time of the invention. Indeed, as discussed above the combination of references Atia, Clausen and Fukuchi would also lead to an OOK intensity modulation scheme, if anything. Thus, for at least the foregoing reasons Appellants respectfully submit that claims 1 and 16 are non-obvious over Atia in view of Clausen and Fukuchi.

6. Fact that return-to-zero phase shift keying for multi-channel long-haul transmission was widely researched only <u>after</u> Appellants' disclosure is strong evidence of non-obviousness

In further support of the non-obviousness of Appellants' claims, Appellants respectfully refer to a Declaration under 37 C.F.R. 132, executed by the inventors on September 13, 2007 and submitted September 17, 2007, to show the contrast in the number of reported activities of RZ-DPSK in fiber transmission, before and after the report of experimental results of the present invention at the 2002 Optical Fiber Conference (OFC 2002, FC2, p. 2 Exhibit A), one of the most well-attended conferences in optical communications technology.

As shown in the Declaration and associated Exhibits, there was no report of RZ-DPSK in fiber transmission link in the post-deadline session of OFC 2001, i.e., prior to Appellants' FC2 paper in 2002.

However, in 2003, the year after Appellants' report, 50% of the post-deadline papers (five out of a total of ten) in the Optical Fiber Transmission session at OFC 2003 relate to RZ-DPSK in fiber transmission. Specifically, the original FC2 paper submitted by Lucent Technologies, Inc. in 2002 was directly referenced in four of these post-deadline papers on RZ-DPSK (and indirectly referenced in the fifth paper). The fact that Appellants' method was widely adopted, referred to, and followed by Appellants' peers after the 2002 report provides convincing evidence of the non-obvious nature of the method.

7. *Examiner Fails to Give Proper Weight to Appellants' Arguments*

In the final Office Action, the Examiner dismisses portions of Appellants' prior responses as mere statement or argument by the Appellants' attorney. (See final Office Action p. 6). Appellants respectfully submit that such treatment by the Examiner is erroneous because Appellants' arguments were not the words of counsel, but were based upon quotations direct from the Appellants' Specification, which is sworn to by the Inventors/Appellants, or referred directly to peer publications. Thus, to the extent that the Final Office action discounts Appellants' previous arguments, Appellants submit that the rejection over Atia, Clausen and Fukuchi under 35 U.S.C. §103 is improper. See MPEP 716.01(a): "Examiners must consider comparative data in the specification which is intended to illustrate the claimed invention in reaching a conclusion with regard to the obviousness of the claims." (citing, *In re Margolis*, 785 F.2d 1029, 228 USPQ 940 (Fed. Cir. 1986)).

For at least the foregoing reasons, Appellants respectfully submit the Office Action fails to establish the obviousness Appellants' independent claims 1 and 16 over the combined teaching of Atia, Clausen and Fukuchi. Moreover, claims 10-13, 15, 21, 24-25 and 28 depend from claims 1 and 16 respectively, and recite additional limitations. As such, and for at least the same reasons stated above, these claims are also patentable over Atia, Clausen and Fukuchi. Therefore, the rejection of claims 1, 10-13, 15-16, 21, 24-25 and 28 should be withdrawn.

Claims 22-23 and 26-27

Claims 22-23 and 26-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Atia, Clausen and Fukuchi and further in view of Doran. The rejection is traversed.

Each ground of rejection applies only to dependent claims, and each is predicated on the validity of the rejection of claims 1 and 16 under 35 U.S.C. 103 over Atia, Clausen and Fukuchi. Since the rejection of claims 1 and 16 under 35 U.S.C. 103 over Atia, Clausen and Fukuchi has been overcome, as described hereinabove, and there is no argument put forth by the Office Action that Doran supplies that which is missing from Atia, Clausen and Fukuchi to render the independent claims obvious, these grounds of rejection cannot be maintained.

Furthermore, Appellants note that Doran is only a single wavelength channel system and is therefore not concerned with inter-channel effects. (See Doran col. 2 lines 41-43 and col. 3 lines 2-7). In addition, Doran is silent with respect to phase shift keying and only appears to implement an intensity modulation format such as OOK. Thus, Appellants respectfully submit any combination of Atia, Clausen and Fukuchi with Doran would further lead one of ordinary skill to an OOK modulation format for long-haul transmission and therefore away from the RZ-DPSK WDM system of Appellants' independent claims 1 and 16.

Therefore, the rejection of claims 22-23 and 26-27 should be withdrawn.

CONCLUSION

Thus, Appellants submit that all of the claims presently in the application are allowable.

For the reasons advanced above, Appellants respectfully urge that the rejection of claims 1, 10-13, 15, 16 and 21-28 is improper. Reversal of the rejection of the Final Office Action is respectfully requested.

Respectfully submitted,

Dated: 5/18/09

E J Wall

Eamon J. Wall
Registration No. 39,414
Wall & Tong, L.L.P.
595 Shrewsbury Ave. Suite 100
Shrewsbury, NJ 07702
Telephone: (732) 842-8110 X120
Facsimile: (732) 842-8388
Attorney for Appellant(s)

CLAIMS APPENDIX

1. (previously presented) Apparatus adapted for use in long haul transmission in an optical communication system, comprising:

at least one modulator, for modulating an optical phase of pulses within a sequence of return-to-zero (RZ) pulses having a duty cycle of less than or equal to approximately 33% to form an optical phase modulated signal encoded by one of phase shift keying (PSK), differential phase shift keying (DPSK) or quadrature phase shift keying (QPSK) in accordance with an input digital data stream;

a wavelength division multiplexer adapted to combine an output signal of said at least one modulator with other optical phase modulated signals having optical carriers with different wavelengths;

a dispersion managed optical transmission medium for transmitting an output wavelength division multiplexed signal of said wavelength division multiplexer; and

a means for transmitting the wavelength division multiplexed signal in the dispersion managed optical transmission medium.

2-9. (canceled)

10. (previously presented) The invention defined in claim 1 wherein said at least one modulator is a LiNbO3 phase modulator.

11. (previously presented) The invention defined in claim 1 wherein said at least one modulator is a LiNbO3 Mach-Zehnder phase modulator.

12. (previously presented) The invention defined in claim 1 wherein said apparatus further comprises at least one receiver including a delay demodulator for receiving said input digital data stream from the dispersion managed optical transmission medium.

13. (previously presented) The invention defined in claim 1 wherein said apparatus further comprises a receiver including at least one balanced receiver for recovering said input digital data stream from a transmitted wavelength division multiplexed signal.

14. (canceled)

15. (previously presented) The invention defined in claim 1 wherein said transmission medium includes discrete or distributed means of erbium-doped fiber amplification (EDFA) or Raman amplification.

16. (previously presented) A method of transmission for long haul optical communications, comprising the steps of:

modulating an optical carrier signal in a sequence of return-to-zero (RZ) pulses having a duty cycle of less than or equal to approximately 33%;

modulating an optical phase of said pulses in accordance with an input digital data stream to form an optical phase modulated signal via one of phase shift keying (PSK), differential phase shift keying (DPSK) or quadrature phase shift keying (QPSK);

combining said optical phase modulated signal with other optical phase modulated signals having optical carriers with different wavelengths to form a wavelength division multiplexed signal; and

transmitting said wavelength division multiplexed signal in a dispersion managed optical transmission medium.

17-20. (canceled)

21. (previously presented) The method of claim 16, wherein dispersion management is provided by applying pre-dispersion compensation and post-dispersion compensation to said wavelength division multiplexed signal.

22. (previously presented) The method of claim 16, wherein dispersion management is provided by soliton transmission of said wavelength division multiplexed signal.

23. (previously presented) The method of claim 22, wherein the dispersion managed optical transmission medium comprises a plurality of serially interconnected fibers arranged such that adjacent interconnected fibers have alternating and opposite dispersion characteristics.

24. (previously presented) The method of claim 16, wherein the dispersion managed optical transmission medium comprises one or more optical fibers exhibiting a high chromatic dispersion.

25. (previously presented) The apparatus of claim 1, wherein dispersion management is provided by applying pre-dispersion compensation and post-dispersion compensation to said wavelength division multiplexed signal.

26. (previously presented) The apparatus of claim 1, wherein dispersion management is provided by soliton transmission of said wavelength division multiplexed signal.

27. (previously presented) The apparatus of claim 26, wherein the dispersion managed optical transmission medium further comprises a plurality of serially interconnected fibers arranged such that adjacent interconnected fibers have alternating and opposite dispersion characteristics.

28. (previously presented) The method of claim 11, wherein the dispersion managed optical transmission medium comprises one or more optical fibers exhibiting a high chromatic dispersion.

EVIDENCE APPENDIX

None

RELATED PROCEEDINGS APPENDIX

None